Summary and Next Steps
Renewable Energy Modeling Series
Modelers' Working Group
June 13, 2003

Next Steps

A summary of results of the wind meetings will be posted on the internet site and used for further discussions of modeling priorities. Details of the next working group meeting will be planned in the coming months, and this meeting will likely focus on quantifiable factors that affect choices among electricity generation sources and are not well-represented in large national energy models, such as Green Power purchases.

Results Summary

Introduction

Tom Kerr, EPA Energy Supply and Industry Branch, introduced the meeting, explained EPA's interest in the Renewable Energy Modeling Series, summarized the previous meeting results, highlighted some of the lessons learned to date, and suggested some goals for this and subsequent meetings.

The Climate Protection Partnerships Division of EPA develops voluntary programs to address greenhouse gas emissions, including those from the energy sector. In this regard, EPA is seeking to encourage the use of renewable energy technologies for their environmental benefits, and wants to understand the future opportunities and challenges for the technologies. The Energy Supply and Industry Branch (ESIB) has a Green Power program in which it encourages companies to purchase renewable electricity. The Renewable Energy Modeling Series grew from ESIB's interest in doing more to understand and achieve the environmental benefits of renewable energy. Based on discussions with Skip Laitner (EPA-OAR), DOE, ACRE, and NREL, Tom Kerr developed the Renewable Energy Modeling Series as a forum to convene modelers to assess the status and potential improvements to renewable energy modeling.

The first meeting in the Renewable Energy Modeling Series convened policy makers to identify their renewable energy analysis needs. The second meeting focussed on wind energy modeling.

This meeting concludes the consideration of wind energy modeling, and continues discussion of the overall economic framework for energy modeling and the consideration of externalities in energy models.

Session 1. Wind Energy Modeling

Updates on Wind Modeling Efforts

Walter Short, National Renewable Energy Lab, presented "WinDS – Wind Deployment Systems Model: An Update," with results from initial modeling. He briefly described the model structure, which was presented in greater detail during the previous meeting. He noted that WinDS is not intended to represent the energy sector in a comprehensive way, but instead is meant to be able to look at wind-specific issues in detail. Modeling capabilities that are unique to WinDS include detailed modeling of the effects of transmission constraints, wind intermittency and wind resource access.
Walter discussed the important inputs and presented results, which may be viewed in the presentation. WinDS is still being improved. Next steps will include analyzing wind-specific

market issues, using the WinDS results in other models, and improving how additional technologies are represented in the model.

Questions from the audience highlighted that WinDS assumes that the entire interconnection region is available for using any surplus wind and for wheeling. Jim Caldwell suggested that assigning transmission costs on a nameplate or pancaking basis might be closer to actual practice than assigning costs on a per kWh per mile basis. Another question related to the opportunity for new wind lines to serve other sources such as gas, which Jim Caldwell suggested was limited except perhaps in Wyoming, where small amounts of coal bed methane could be used to generate electricity if more transmission were available. Jim pointed out that tariff and contract terms limit the usage of the current transmission system, which could carry 10-40% more just by changing these rules. Walter noted that WinDS does not take into account tariff and contract constraints. In response to questions about the role of wind technology improvements, Walter discussed an estimate of wind penetration that would occur even if there were no technology improvement. This scenario shows that over 100 GW would still be used by 2050, as opposed to the 300 GW estimate with base case assumptions about technology improvements. In response to a question about the effect of wind putting downward pressure on natural gas prices due to competition, Walter explained that the model does not have the capability to model that. Also, the modeling effort has not yet examined alternative demographic scenarios, which could change the distribution of demand and change the locations of wind development. The assumptions used in the model terminate the production tax credit in 2003.

Chris Namovicz, Energy Information Administration, presented "Update to the NEMS Wind Model," including a summary of major changes that he is making to the NEMS model's representation of wind. The presentation emphasized the changes in modeling cost and impacts of intermittency, and other changes include cost and performance learning. Chris explained that the former modeling system used a firm constraint that effectively limited wind penetration to 10-15%, whereas the new method estimates the cost of the ancillary services needed to address intermittency as wind penetration increases. These costs are low, often zero until substantial wind is used. A challenge is that NEMS does not handle transmission in a detailed way, and so it is impossible to model ancillary services with consideration of the actual transmission system, which would be more accurate than assigning ancillary service needs to generators.

Chris presented current market practices and modeling alternatives for granting capacity credit to wind farms. Market practices are likely to be guided by FERC's preference for approaches that do not pose "'arbitrary' penalties on intermittent resources. For modeling in NEMS, Chris plans to develop a capacity credit algorithm that reduces the amount of capacity credit granted as intermittent resource use increases.

The concept of "1:1 backup" at high penetrations of wind raised vocal objections among the audience, as did the idea that an absolute limit on penetration of intermittent resources would be imposed. Much of this debate highlighted the need for real-world data on the performance of wind projects in capacity markets.

Chris presented his recent work to improve NEMS modeling of effects of wind intermittency on its performance and value. One goal for improvement is to develop a way to estimate the costs of dealing with surplus wind, as an alternative to the current 20% limit that is imposed to avoid surplus wind. This constraint does affect model results. Other recent work focuses on the correlation among wind sites. Chris has estimated effects on reliability based on different assumptions about the degree of correlation. What is needed is wind data that can be used to determine the actual degree of correlation.

Intermittency

Charlie Smith, Utility Wind Interest Group, presented "Wind Power Impacts on System Operation: A Case Study." This topic was selected for a case study based on a survey that

indicated high UWIG member interest. The case study participants included UWIG, NRECA, APPA, WAPA, DOE, NREL, and Xcel Energy, with its Buffalo Ridge facility as the study site. This study helps utilities transition from thinking about limits on wind penetration, to thinking about the costs of managing the operating impacts of every larger wind plants, with ancillary services available from a large area.

Xcel provided a good context for the case study because of their plans to add lots of wind to NSP system, which gave them a practical interest in quantifying the costs of ancillary services. One major question was how the algorithm for unit commitment should be changed, based on wind availability, given some level of accuracy in predicting wind plant output. The case study involved simulation of several different cases, including a worst case scenario, a base case, and other sensitivity analyses. Time series production profiles for different time scale were combined to develop a Monte Carlo simulation, and conventional utility simulation tools were used over the different time scales to simulate system performance.

Results showed a range of cost of wind forecasting inaccuracy at 5% wind penetration from 0.28 – 1.38 $/MWh as inaccuracy went from 0.1 to 0.5. Studies currently under way with wind penetration up to 15 or 20% are finding ancillary service cost ranging up to $3.50/MWh.

In response to a question, Charlie explained that control area for this study is the Northern States Power area, and that if you spread out access to ancillary services over a wider area then their cost would decline. Jim Caldwell emphasized that this approach, exporting the need for ancillary services, can be the easiest way to meet these needs, and gave an example from the Pennsylvania-New Jersey-Maryland region. In response to a question from Joe Cohen, Charlie noted that ancillary services costs are greatest during off-peak rather than on-peak time periods.

Plato Koptilov, PacifiCorp, presented “Modeling Wind Energy Integration Costs.” Plato said that PacifiCorp’s current wind generation includes facilities at Stateline and in Wyoming, and that it expects to expand that by over 1000 MW over next 10 years, because wind reduces cost and risk of its generation portfolio. Plato noted that the availability of local expertise for wind farm operation within the region will also aid project development. PacifiCorp has not yet identified the good sites for building up its wind capacity, but they do want a diversity of locations. Plato also mentioned that they must buy firm, annual transmission, and can’t take advantage of the seasonal variation in wind.

PacifiCorp needed to develop methods for estimating wind integration costs that would convince the Public Utilities Commission that their wind generation portion of their integrated resource plan was appropriate. They developed this method with a focus on load following reserve requirements for system operation on the minutes-to-hours time frame, ignoring load control at shorter time frames. They performed simulations that showed that low penetration levels require little if any incremental reserve requirement, but rises rapidly to a 1:1 increased reserve requirement at or above 25% penetration, with substantial differences between the eastern and western portions of their grid. In another study, an operations study, operators noticed a wind system impact about 2% of the time, but generally ran the system as they would have without wind, and the wind does not impose requirements for operator intervention. This study suggested a marginal impact on load following, and a slight value to wind forecasting.

PacifiCorp’s proposed integrated resource plan was issued this year, and calls for 1400 MW of renewable energy over the next 10 years, mostly wind.

Questions related to the use of hydro resources for peaking power, and Plato did not know what portion of the hydro could be used in this way. There are substantial uncertainties about hydro relicensing, and the flexibility of hydro for wind storage may vary substantially with time frame, such that little seasonal storage but lots of hour-to-hour storage may be available. They are trying to develop metrics to characterize this flexibility, and are re-examining how to operate wind

and hydro together on their system. An audience member commented on a study of the benefits of HydroQuebec reservoir management to wind generation in Vermont.

Ken Donohoo, Electric Reliability Council of Texas, presented on wind power issues in Texas transmission planning. Ken indicated that major new transmission lines were proposed to connect to West Texas, even without consideration of wind development there. In addition, $150 million in transmission lines have been approved just to serve wind farms. Concerns about wind generation in West Texas relate to very challenging voltage control issues there, which are limiting the output that wind farms may provide. ERCOT is working on reactive standards that may allow wind farm to put reactive control in themselves, or may give them the alternative to pay for it on the transmission system. Transmission is a significant, daily constraint on current wind farm output in West Texas. Concerns about regulation also arise because of possible scenarios in which lots of wind and natural gas generation is being used, but no base load is on. Substantial wind stability modeling is being undertaken.

Regarding planning and building transmission to facilitate future renewable energy development, Ken emphasized that transmission lines take at least 5 years from initial plan to completion, and that it's very hard to build them in advance of development. There are major concerns about the cost of transmission to the customers, and transmission owners are concerned about return and cost recovery. This can present a challenge for renewable energy developers. Ken pointed out that extensive data has been developed, and is publicly available, about West Texas regional transmission planning.

Discussion raised questions about what would constitute adequate reactive control at a wind farm, and pointed out the disconnect between the turbine manufacturers' cycle for planning turbine control capabilities, compared to what the grid operators want. Initially, grid operators just wanted to be able to disconnect the wind, but now they want better control of the turbines. Also discussed was the high need for ancillary services that is linked to the weak transmission capability.

Resource Assessment and Accessibility

Marc Schwartz and Donna Heimiller, National Renewable Energy Lab, addressed this topic in a joint presentation. Marc described the updating of the wind resource maps, which is under way for most of the U.S. The next maps to be completed are of Arizona, Colorado, Utah, and Nevada. The new maps are being used in a new calculation of Available Windy Land. This data contributes to the development of region and state supply curves for wind, and is being used to update NEMS inputs.

Donna addressed a study of renewable energy development potential on BLM lands. This study encouraged lots some interest in project development on BLM lands, especially in Nevada, where many of the potential renewable energy sites are on BLM lands. Discussion pointed out that developers are unlikely to choose public lands if private lands are readily available. Further discussion also revealed that land access is more important, earlier in the development process, for the wind industry in the East, where a similar study of National Forest lands might also be useful.

Donna also provided an overview of wind-related GIS analyses such as the Clean Power Estimator that shows the net present value of small wind, data processing for WinDS, and wind site analysis.

Wind Energy Modeling Summary Discussion

Jim Caldwell offered summary comments to start the final discussion of wind energy modeling. He observed that data needs are more pressing than modeling needs. For a wide variety of different studies to address wind energy modeling questions, data collection and validation is a more important limit than model development. He pointed out that industry has substantial opportunities to collect data in ways that don't necessarily require more money but do require better organization and communication. Some of the most important areas of additional work to determine wind potential are:

- Definitions of regions for purposes of identifying and meeting ancillary service needs
- Tariff requirements that affect ancillary service needs
- Approach to identifying transmission needs
- Measuring system flexibility

Major data needs include:

- Resource characterization including seasonal and diurnal variation
- Locational marginal price
- Timing and location of transmission availability
- Utility system load data

On behalf of the American Wind Energy Association, Jim suggested that industry can communicate more clearly about the timing and content of data and studies that are needed in order to prioritize activities and make better use of ongoing industry and DOE efforts.

Session 2. Introduction to Environmental Externalities

Rick Morgan, EPA Climate Protection Partnerships Division, presented on "Estimating the Environmental Benefits of Renewable Energy." Rick described the challenge of estimating benefits of renewable energy when that requires estimation of what would have happened in its absence. System average emission rates could be used for this estimate, actual displaced emissions would not be system average emission rates but marginal emission rates. This can yield quite a different answer, for example, if natural gas is often on the margin, the natural gas emission rate would be a better estimate. Estimation of marginal emission rates may be accomplished using dispatch models, planning models, or simplified spreadsheet-based calculations. Rick noted many options in defining marginal emissions, including the number of plants to be considered and other factors listed in the presentation. The Average Displaced Emissions Rate (ADER) work of EPA is one approach. It includes technology specific results for 14 different energy efficiency and clean energy technologies. The technologies have different load shapes that can influence displaced emissions by a factor of 2-3. The marginal emissions rate varies over the years because generation mix especially marginal plants vary.

The group discussed the results of the preliminary calculation of displaced carbon dioxide emission rates for wind, which show rates for each of the 5 ADER regions. The early years have much lower displaced emissions rates than the later years, which appeared incorrect to the group.

In addition to other uses for displaced emission values, Rick noted the possible application of displaced emissions calculations to State Implementation Planning. Because of the criteria for creditable emissions reductions in SIPs (including permanent, verifiable, additional, quantifiable within a state), the challenges of proving where and how much emissions reduction achieved are substantial in this application.

In response to a question, Rick noted that emissions other than carbon dioxide were dropped from the ADER calculations because of quantification challenges.

Frank Divita, E.H. Pechan & Associates, presented "Translating Pollution Prevention into Health, Mortality, and Other Environmental Benefits: Domestic Co-Benefits from Adoption of Clean Energy Policies to Reduce Greenhouse Gas Emissions." This study used the Clean Energy

Futures Advanced Scenario in 2010 to look at co-benefits by estimating emission reductions by NERC region, economic sector, and fuel, for utility, industrial, residential, commercial sectors, for coal, oil, natural gas combustion sources only. It was assumed that programs to attain National Ambient Air Quality Standards would be implemented, but that the CEF technologies would offsets implementation cost. Thus, cost savings from CEF scenarios were attributed to specific pollutant-related programs. Emissions reductions were assumed to be directly proportional to fuel reductions. Most of the ambient air quality benefit is seen in the Great Lakes and Eastern regions. The excess mortality estimates use methods that were developed for Regulatory Impact Analysis. The avoided mortality map is different because of population weighting.

The study included ecological effects, such as nitrogen deposition into East Coast and Gulf estuaries and visibility improvements. The biggest visibility impact of the CEF technologies occurs in the southeast because of the interactions there between pollution and humidity.

Skip Laitner, EPA Office of Atmospheric Programs, presented "Reflecting Costs and Benefits Within Efficiency and Renewable Energy Technology Policy Scenarios." Skip's presentation addressed the questions of why it is important to consider externalities, what frameworks can be used to organize consideration of externalities, and presented a heuristic analysis demonstrating the potential role of externalities in differentiating technologies. The heuristic model of a technology choice algorithm (see presentation and journal article) explored the impact of technology learning, energy efficiency, and non-energy benefits on the relative penetration of different technologies.

Overall Discussion, Conclusions, and Next Steps

Tom Kerr concluded the meeting by offering some thoughts about future topics, and by facilitating a discussion on future directions. Some ideas included discussion of use of externalities, green power premiums, and hedging value of renewable energy. Another option would be to examine another renewable energy technology as has been done with wind energy. Biomass was discussed as a potential focus, with comments from Zia Haq and Pat Delaquil reporting biomass-related activities and issues. Long term modeling on biomass and carbon sequestration is being conducted through EMF21. EIA and Pacific Northwest National Lab are planning discussions on biomass assumptions because of PNNL modeling that develops scenarios with very aggressive growth in biomass use.